United States General Accounting Office

GAO



Report to the Chairman, Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, House of Representatives

November 1991

# OZONE-DEPLETING CHEMICALS

## Increased Priority Needed If DOD Is to Eliminate Their Use



GAO/NSIAD-92-21

GAO

**United States**
**General Accounting Office**
**Washington, D.C. 20548**

**National Security and**
**International Affairs Division**

B-246019

November 13, 1991

The Honorable John D. Dingell
Chairman, Subcommittee on Oversight
and Investigations
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

This report responds to your request that we review the initiatives the Department of Defense (DOD) is taking to phase out ozone-depleting chemicals. DOD has taken some positive steps to abate its use and emissions of ozone-depleting chemicals. However, it has not initiated other actions that are critical to phasing out these regulated chemicals cost-effectively.

As agreed with your office, unless you publicly release its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies to other appropriate congressional committees; the Secretaries of Defense, the Army, the Navy, and the Air Force; the Administrator, Environmental Protection Agency; and the Director, Office of Management and Budget. We will also make the report available to other interested parties upon request.

Please contact me at (202) 275-4268 if you or your staff have any questions concerning this report. Major contributors to this report are listed in appendix II.

Sincerely yours,

Nancy R Kingsbury

Nancy R. Kingsbury
Director
Air Force Issues

# Executive Summary

## Purpose

The Department of Defense (DOD) is a major user of chemicals that are linked to the depletion of the earth's stratospheric ozone layer, which protects the earth from damaging ultraviolet rays. Recent scientific data suggest that the ozone layer is decreasing at a faster pace than previously projected. According to the Environmental Protection Agency, this condition could increase the number of deaths from skin cancer over the next 50 years by about 200,000. Stratospheric ozone depletion has been identified by the Environmental Protection Agency as one of its most critical environmental problems.

The Chairman, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, requested that GAO assess the progress made by DOD in phasing out its use of ozone-depleting chemicals. More specifically, GAO was asked to determine what DOD is doing to (1) reduce ozone-depleting chemical releases, procurement, and use; (2) identify specific uses of ozone-depleting chemicals; (3) fund research and development programs to identify and implement alternatives; (4) limit the use of these regulated chemicals in existing and new systems; and (5) revise military specifications and standards that specify the use of ozone-depleting chemicals.

## Background

An international treaty, the "Montreal Protocol on Substances that Deplete the Ozone Layer," and the Clean Air Act Amendments of 1990 require that the production and consumption of chlorofluorocarbons, halons, carbon tetrachloride, and methyl chloroform be phased out early in the 21st century. Neither the Montreal Protocol nor the Clean Air Act define or restrict the use of ozone-depleting chemicals.

DOD procures significant quantities of ozone-depleting chemicals each year. It purchased over 16 million pounds of regulated chemicals in 1990. These chemicals were used primarily as coolants, cleaning solvents, degreasers, and fire-fighting suppressants in aircraft, ships, combat vehicles, and buildings.

The Montreal Protocol and Clean Air Act do not prohibit users from establishing reserves for use beyond the production phase-out date. DOD plans to build strategic reserves for mission critical uses to ensure it can operate existing equipment until it can (1) implement alternative chemicals or (2) retire existing equipment from its inventories. DOD defines mission critical uses as those that either have a direct impact on combat mission capability or affect operability of combat mission assets.

## Results in Brief

DOD has taken some initiatives within the last 4 years to abate its use and emissions of ozone-depleting chemicals. However, it has not taken other initiatives to eliminate its use of ozone-depleting chemicals and continue its mission requirements beyond the time when these chemicals are no longer commercially produced. More specifically, DOD has not sufficiently (1) clarified mission critical use, (2) identified specific chemical uses and quantities, (3) given priority to research, development, and testing activities required to implement successful alternatives, (4) justified the need to install equipment that uses regulated chemicals in new and existing systems, and (5) revised or changed its military specifications and standards to facilitate the use of substitutes or alternative technologies. Unless DOD takes positive action now in several key areas, it is likely to have to continue using ozone-depleting chemicals for many years after the scheduled production phase-out.

## Principal Findings

### Some Initiatives Undertaken

DOD has taken some initiatives to reduce ozone-depleting chemical uses and emissions. It has established internal programs as well as joint efforts with industry and federal agencies to identify and develop alternatives and solutions. DOD is also evaluating, purchasing, and using refrigerant and halon recovery and recycling equipment and has reduced its halon emissions during training and testing activities.

### More Needs to Be Done

DOD has not taken certain actions that are needed to eliminate its use of ozone-depleting chemicals. First, the Office of the Secretary of Defense has defined mission critical uses so broadly that the military departments have significant latitude in identifying uses that can continue beyond the planned production phase-out. For example, while the Army's only mission critical use of halon is for explosion suppression in the crew and turret areas of specific combat vehicles, the Navy has categorized all shipboard, aircraft, and aviation flightline uses as mission critical.

Second, DOD has neither identified nor tracked all of its ozone-depleting chemical usage quantities, specific uses, and emissions. Consequently, the military departments are not fully aware of where and in what quantities all the regulated chemicals are used.

Third, DOD is not providing sufficient resources to evaluate alternatives for ozone-depleting chemicals, especially in areas where there is no ongoing commercial research. It estimates the costs will be about $250 million to test, evaluate, and qualify new materials for mission critical applications. However, the Office of the Secretary of Defense and military departments are slow in providing the resources to ensure that safe and acceptable alternatives will be available to support DOD's phase-out of these regulated chemicals.

Fourth, DOD is continuing to install equipment that uses ozone-depleting chemicals in existing and new aircraft and ships. For example, the Navy is installing halon portable fire extinguishers on 226 existing surface combatants in place of carbon dioxide portable fire extinguishers.

Fifth, over 9,600 military specifications and standards currently require contractors to use ozone-depleting chemicals. In many cases, DOD could opt for using nonmilitary specifications and standards that would promote the development and use of safe and acceptable alternatives. However, as of September 1, 1991, DOD has revised only one standard to allow the use of alternatives.

## Recommendations

To ensure DOD can successfully minimize the amount of strategic reserves to be established and avoid relying on ozone-depleting chemicals further into the 21st century than necessary, GAO recommends that the Secretary of Defense

- clarify the definition of mission critical uses to minimize continued use of regulated chemicals and ensure consistent approaches among the military departments;
- establish a mechanism to track its specific uses, quantities, and emissions to ensure all usage will be identified and eliminated;
- ensure the appropriate priority is given to research and development for applications that have no ongoing commercial research;
- establish criteria for reviewing ongoing and proposed projects that use regulated chemicals in existing and new systems to ensure these uses are justified; and
- expedite the use of nonmilitary specifications and standards to replace the military specifications and standards that currently require the use of ozone-depleting chemicals.

## Agency Comments

As requested, GAO did not obtain written agency comments on this report. However, GAO discussed its findings with agency officials and incorporated their comments where appropriate.

# Contents

# Figures



## Abbreviations

| | |
|---|---|
| CFC | Chlorofluorocarbon |
| DOD | Department of Defense |
| HCFC | Hydrochlorofluorocarbon |
| ODC | Ozone-depleting chemical |
| OSD | Office of the Secretary of Defense |

# Introduction

The Department of Defense (DOD) and private industry use chlorine- and bromine-based chemicals to cool, clean, and protect their equipment and buildings. Scientists have linked these chemicals to the depletion of the stratospheric ozone layer. The ozone (triatomic oxygen) is a critical component of the earth's stratosphere[1] that absorbs much of the sun's destructive ultraviolet radiation.

Ozone-depleting chemicals (ODC) include several classes of chemicals—chlorofluorocarbons (CFC), halons, and hydrochlorofluorocarbons (HCFC)[2] —as well as two individual chemicals—methyl chloroform and carbon tetrachloride. The United States, along with numerous other countries that manufacture and use these chemicals, have agreed to phase out their production and consumption in an effort to preserve the ozone. This report discusses the (1) initiatives DOD is taking to phase out these ozone-depleting chemicals and (2) activities that still need to be taken to ensure that DOD can minimize its development of strategic reserves and phase out its use of ODCs.

## Background

In 1974, scientists first raised concern about possible depletion of the ozone layer from CFC emissions. Ozone depletion increases the amount of harmful ultraviolet radiation reaching the earth's surface and, among other things, can result in adverse consequences for human health. Scientists believe that chlorine released from CFCs acts as a catalyst by repeatedly combining with and breaking apart ozone molecules, depleting the ozone layer and allowing more ultraviolet radiation to penetrate to the earth's surface.

The most recent scientific data suggest that the ozone layer is decreasing at a faster pace than previously projected. The Environmental Protection Agency has identified stratospheric ozone depletion as one of its most critical environmental problems. The Agency now projects this condition may increase the number of skin cancer deaths in the United States over the next 50 years by about 200,000 as well as create other severe health problems. Even though scientists have not been able to unequivocally relate these chlorine- and bromine-based chemicals to ozone depletion, the international consensus is that these chemicals play

[1]The stratosphere is a layer of the atmosphere that ranges from approximately 10 to 30 miles above the earth's surface.

[2]Currently, 15 CFCs and 3 halons are regulated by the international treaty and U.S. law. The international treaty regulates 34 HCFCs, while U.S. law regulates 33 HCFCs.

a decisive role in decreasing the stratospheric ozone layer. Consequently, the United States and numerous other countries have agreed to phase out the production of these chemicals in an effort to protect the ozone.

## Limitations Established by International Treaty and Domestic Law

An international treaty, the Montreal Protocol on Substances that Deplete the Ozone Layer, and the Clean Air Act Amendments of 1990 require manufacturers to phase out the production and consumption of ozone-depleting chemicals to protect the stratospheric ozone. Although the international treaty and U.S. law are similar, the Clean Air Act Amendments of 1990 provide that the more stringent provision governs when the treaty and the act conflict within the jurisdiction of the United States. The international treaty defines production as the amount of controlled chemicals produced, minus the amount destroyed by approved technologies and the amount entirely used as feedstock in the manufacture of other chemicals, while U.S. law defines production as a substance manufactured from any raw material or feedstock chemical. Consumption, which is defined similarly by both the international treaty and domestic law, is the production of controlled chemicals, plus imports, minus exports of controlled chemicals. Neither the Montreal Protocol nor the Clean Air Act defines or restricts the use of ozone-depleting chemicals. The term consumption, which is defined, does not represent actual use.

In September 1987, the United States, along with 23 other nations and the European Economic Community, signed the Montreal Protocol. The Protocol became effective on January 1, 1989. It originally required chemical manufacturers to freeze production and consumption of five CFC chemicals at 1986 levels beginning in July 1989, followed by phased-in reductions of at least 50 percent by July 1998. Beginning in February 1992, the Protocol also required the signing countries to freeze the production and consumption of three halons at 1986 levels.

Due to increasing scientific evidence indicating that the depletion of stratospheric ozone is more severe than originally estimated, the Montreal Protocol was strengthened. In June 1990, the parties to the protocol agreed to completely phase out CFC production and all but essential[3] halon production by 2000. An agreement was also reached to

[3]The parties to the Montreal Protocol have not defined essential halon use. However, by January 1993, the parties are required to adopt a decision identifying essential halon uses.

phase out the production and consumption of methyl chloroform, carbon tetrachloride, and 10 other CFCs.

To achieve the phase-out, chemical manufacturers are required to reduce their CFC production by 50 percent of their 1986 production levels by 1995 and by 85 percent by 1997. Production and consumption of CFCs, halons, and carbon tetrachloride are to be eliminated by 2000 and methyl chloroform production by 2005.[4] Nonbinding resolutions also were reached to (1) restrict the use of HCFCs to areas where other alternatives are not available and phase out the production of HCFCs no later than the year 2040 and (2) prohibit the production and consumption of other halons that are not currently regulated by the Montreal Protocol.

In November 1990, the President ensured the adoption of unilateral U.S. controls on ozone-depleting chemicals by signing into law the Clean Air Act Amendments of 1990. Title VI of this legislation mandates more stringent reductions of CFCs and halons than the Montreal Protocol. According to U.S. law, both CFC and halon production levels must be reduced by 25 percent of the 1986 manufacturers' production levels by 1993, 50 percent of 1986 production levels by 1995, and 85 percent of 1986 production levels by 1997. Furthermore, all CFC production is to be eliminated by the end of 1999 and production of all but essential halons are to be eliminated by 2000.

The Clean Air Act Amendments phase out the production of carbon tetrachloride by 2000, which is the same year as the Montreal Protocol. However, the Amendments include an 85-percent reduction from 1986 production levels by 1995. The act phases out methyl chloroform production 3 years earlier than the Montreal Protocol, with gradual reductions of 10 percent from 1986 production levels by 1993, 30 percent by 1995, and 80 percent by 2000. However, limited quantities may be produced solely for use in essential applications, such as nondestructive testing for metal fatigue and corrosion of existing airplane engines until January 2005. In addition, beginning in 2015, HCFC use will cease unless the chemical (1) has been recovered or recycled, (2) is used and entirely consumed in the production of another chemical, or (3) is used as a refrigerant for heat transfer in appliances manufactured up to January 1, 2020.

[4]The Protocol contains a 10-year extension for the basic domestic needs of any party that is a developing country.

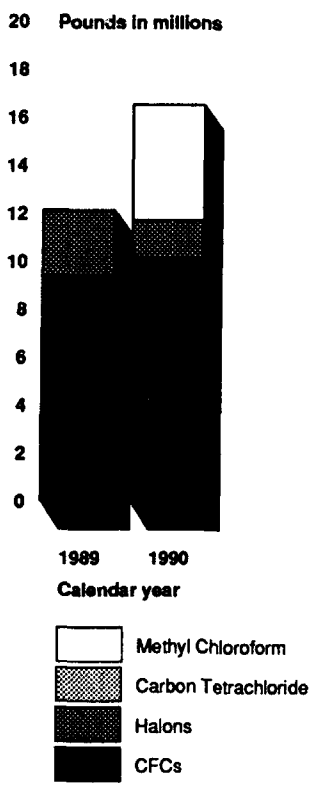
## DOD Procures Large Quantities of ODCs

DOD uses CFC refrigerants primarily in refrigeration systems and chillers on aircraft, missiles, ships, and submarines and in buildings. CFCs are also used as cleaning solvents and degreasers for electronic components, printed circuit boards, and engine parts and as sterilizers for sensitive medical equipment. DOD uses halons primarily as fire-fighting agents in aircraft, combat vehicles, ships, and buildings.

DOD reported that it purchased over 28 million pounds of ozone-depleting chemicals in calendar years 1989 and 1990. Of this amount, about 12.1 million pounds were purchased in 1989 and 16.6 million pounds in 1990. Figure 1.1 breaks out the annual procurement of CFCs, halons, methyl chloroform, and carbon tetrachloride categories for calendar years 1989 and 1990.

Chemical manufacturers and some users are conducting research, development, and testing to identify alternatives for ozone-depleting chemicals. They are concentrating their research efforts in areas having the largest known applications. Although many applications have both civilian and military use, others are unique to DOD.

**Figure 1.1: DOD's Ozone-Depleting Chemical Procurement Quantities in Calendar Years 1989 and 1990**




Note: Procurement amounts for carbon tetrachloride and methyl chloroform were not collected in calendar year 1989. DOD reported that it purchased about 3,000 pounds of carbon tetrachloride in calendar year 1990.

## Mission Critical Needs to Be Met With Strategic Reserves

Since international and domestic restrictions prohibit the production, but not the use of selected ozone-depleting chemicals, DOD plans to establish reserves of these chemicals. Strategic reserves will ensure the availability of adequate supplies for mission critical uses that remain beyond the designated phase-out dates previously cited. The reserves will enable DOD to operate existing systems until alternative chemicals are identified, tested, and implemented, or if modifications are considered to be cost-prohibitive, until existing equipment is retired from its inventories. Although the length of time these strategic reserves will be needed is not yet known, the Navy has estimated that it may take as long as 20 years to completely phase out its use of some regulated chemicals.

To build strategic reserves, DOD plans to recover, recycle, and reclaim existing chemicals as well as to purchase additional chemicals. Recovery

involves removing the chemicals from existing equipment and storing the chemical in a container rather than venting the chemical when the equipment is serviced, repaired, or retired. The recycling and reclaiming processes include cleaning the chemical to remove impurities so it may be reused. DOD has not yet begun to purchase additional chemicals for its strategic reserves, but it already has begun to purchase equipment to recover and recycle chemicals.

## Objectives, Scope, and Methodology

The Chairman, Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, requested that we assess the progress being made by DOD in phasing out the use of ozone-depleting chemicals. More specifically, we were asked to determine what DOD is doing to (1) reduce ozone-depleting chemical releases, procurement, and use; (2) identify specific uses of ozone-depleting chemicals; (3) fund research and development programs to identify and implement alternatives; (4) limit the use of these regulated chemicals in existing and new systems; and (5) revise military specifications and standards that specify the use of ozone-depleting chemicals.

To accomplish our objectives, we examined DOD and service regulations, directives, and guidance pertaining to the reduction of ozone-depleting chemicals. We reviewed the international treaty and U.S. legislation on ozone-depleting chemicals and scientific data on ozone trends. We interviewed officials at the Office of the Secretary of Defense and the Departments of the Air Force, Navy, and Army to determine what activities were underway and what milestones are in place to phase out the use of these regulated chemicals. We also interviewed Environmental Protection Agency officials on DOD's efforts in phasing out ozone-depleting chemicals.

We built upon information gathered to respond to an earlier request by the Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, that we assess the impact on DOD of the potential production phase-out of CFCs and halons in the year 2000. We discussed the information provided in this report with DOD officials and have included their comments where appropriate. However, as requested by the Chairman's office, we did not obtain official agency comments.

We performed this work from April 1991 through September 1991 in accordance with generally accepted government auditing standards.

# Some Progress Is Being Made in Reducing Ozone-Depleting Chemical Uses and Emissions

Since the signing of the Montreal Protocol in 1987 and the Clean Air Act Amendments in 1990, DOD's initiatives have helped reduce ozone-depleting chemical uses and emissions. These initiatives include (1) establishing policy and reduction goals, (2) participating in joint committees to identify alternatives, (3) conserving regulated chemicals, (4) reducing chemical emissions, and (5) prohibiting the use of ozone-depleting chemicals in some new procurements. However, DOD has not taken other initiatives needed to eliminate its use of ozone-depleting chemicals and continue its mission requirements when these chemicals are no longer commercially produced (see ch. 3).

## Establishing Policy and Reduction Goals

DOD has established policy and goals designed to reduce and eventually eliminate the use of ozone-depleting chemicals. The Office of the Secretary of Defense issued DOD Directive 6050.9, "CFCs and Halons," on February 13, 1989, requiring DOD to reduce its long-term dependence on CFCs and halons. The Army and Navy have issued implementing directives. The Air Force regulation was approved in May 1991 and as of September 9, 1991, was in printing.

Currently, the DOD directive on CFCs and halons addresses the Montreal Protocol limitations that went into effect on January 1, 1989. The directive establishes policy and assigns responsibility for managing CFCs and halons, identifying and ranking applications that use these chemicals, decreasing the use of CFCs and halons, conducting programs to develop or evaluate suitable substitutes, and documenting the annual procurements of these chemicals. The Office of the Secretary of Defense is in the process of revising the directive to incorporate the June 1990 changes to the Montreal Protocol and the Clean Air Act Amendments of 1990.

DOD has also established goals for reducing and eventually phasing out its use of ozone-depleting chemicals. The timetable for reducing and eliminating these regulated chemicals was established by the Montreal Protocol and the Clean Air Act Amendments of 1990. The dates include short-term reductions of unnecessary emissions and long-term reductions of ozone-depleting chemicals for three categories of use: mission critical, mission essential, and nonessential.

The Office of the Secretary of Defense has established general guidelines defining the three categories of ozone-depleting chemical use. These include:

- Mission critical uses either have a direct impact on combat mission capability and include uses that are integral to combat mission assets or affect operability of these assets.
- Mission essential uses have an indirect effect on combat mission assets and play an auxiliary role in ensuring the operability of those assets.
- Nonessential uses are all other uses.

Because these usage categories are broadly defined, the military departments may categorize the same use in two different categories. For example, the Army designated its use of halon 1211 in portable fire extinguishers as essential for ground vehicles and aircraft, while the Navy identified its use of halon 1211 as mission critical for aircraft firefighting on flightlines and aircraft carriers. This issue is most relevant for mission critical uses since these uses may be continued beyond the time when others must be phased out.

Generally speaking, however, mission critical uses consist of cooling electronics and weapon systems, and fire and explosion suppression systems on-board aircraft, vehicles, ships, and crafts to protect the lives of personnel. Essential uses include process cooling applications and portable fire extinguishers for area protection of electronics, while nonessential uses include comfort cooling in family housing and installation support activities.

DOD's schedule for reducing the use of ozone-depleting chemicals is shown in table 2.1. A complete phase-out will depend upon the development of safe and acceptable alternatives. For mission critical systems where substitutes are not available or cannot be used, DOD plans to build strategic reserves using recovered, recycled, and reclaimed chemicals and bulk chemical purchases of selected chemicals. The reserves will allow the affected operations to continue for the remaining useful life of the system or until reliable and cost-effective alternatives become available.

**Table 2.1: DOD's Goals for Reducing Ozone-Depleting Chemical Releases, Procurement, and Use**

| | Milestones to | | | | |
|---|---|---|---|---|---|
| **Category** | **Institute plans to reduce unnecessary releases during operation, maintenance, and training** | **Institute plans to eliminate procurement and use** | **Stop use in new procurements** | **Phase-out of current applications to 50 percent of 1986 levels** | **Reduce use in all applications to zero [a]** |
| **CFCs** | | | | | |
| Nonessential | October 1990 | January 1992 | January 1993 | January 1993 | January 1994 |
| Mission essential | October 1990 | January 1993 | January 1994 | January 1995 | January 1996 |
| Mission critical | October 1990 | January 1994 | January 1996 | January 1998 | January 2000 |
| **Halons** | | | | | |
| Nonessential | October 1990 | October 1990 | October 1990 | Not available | January 1994 |
| Mission essential | October 1990 | October 1990 | October 1990 | January 1993 | January 1996 |
| Mission critical | October 1990 | October 1990 | January 1995 | January 1997 | January 2000 |
| **Methyl chloroform** | | | | | |
| Nonessential | January 1992 | January 1992 | January 1993 | Not available | January 1993 |
| Mission essential | January 1992 | January 1992 | January 1993 | January 1994 | January 1995 |
| Mission critical | January 1992 | January 1994 | January 1995 | January 1996 | January 2002 |
| **Carbon tetrachloride** | | | | | |
| Nonessential | January 1992 | January 1992 | January 1993 | Not available | January 1993 |
| Mission essential | January 1992 | January 1992 | January 1993 | January 1995 | January 1996 |
| Mission critical | January 1992 | January 1994 | January 1995 | January 1995 | January 2000 |
| **HCFCs** | | | | | |
| Nonessential | January 1992 | Not available | Not available | Not available | Not available |
| Mission essential | January 1992 | Not available | Not available | Not available | Not available |
| Mission critical | January 1992 | Not available | Not available | Not available | January 2015 |

[a]Except for recycled material use.

## Participating in Joint Committees to Find Alternatives

The National Defense Authorization Act for Fiscal Years 1990 and 1991 (P.L. 101-189) mandated the establishment of the CFC Advisory Committee to study (1) the use of CFCs by DOD and contractors in the performance of contracts for the Department and (2) the cost and feasibility of using alternative compounds for CFCs or alternative technologies that do not require the use of CFCs. In 1990, the CFC Advisory Committee was established with representatives from DOD, the Environmental Protection Agency, and defense contractors. The Committee's report, Recommendations for Eliminating the Use of Ozone-Depleting Compounds in the Defense Sector, was issued to the Senate and House

Committees on Armed Services in July 1991. The Committee is continuing its assessment of various implementation issues encountered in reducing the use of ODCs.

DOD is also participating with the Environmental Protection Agency and private industry through various joint committees to identify safe and acceptable replacements for ozone-depleting chemicals. One such committee is the Halon Alternatives Research Consortium. The Consortium was established in 1989 and has since evolved into the Halon Alternatives Research Corporation and the Government Working Group for Alternatives to Halons. These two organizations support cooperative industry, military, and other government agency efforts that are designed to develop the scientific basis for the commercialization of clean, safe, and reliable fire-extinguishing agents.

Another joint effort among DOD, the Environmental Protection Agency, and industry is the Ad Hoc Solvents Working Group. This group first convened in March 1988 to establish a test procedure for evaluating the cleaning effectiveness of alternative solvents and processes as compared to that achieved by CFC-113. Subsequently, the group has designed a standard electronics board and an evaluation process, both of which are now being used. As a result, several alternatives have been tested and qualified as performing as well as or better than CFC-113.

The Industry Cooperative for Ozone Layer Protection is a consortium of transnational companies, governments, associations, and others that have joined together to coordinate the exchange of nonproprietary information on ODC alternative technologies, substances, and processes. One example of this group's activities is the development and support of an alternative technologies electronic data base to provide CFC users with on-line information on substitute processes, materials, and technologies. The Air Force signed a memorandum of understanding with this group in September 1990, agreeing to cooperate on activities leading to the replacement of CFC-113 and other solvents that deplete the stratospheric ozone.

Additionally, DOD, the Federal Aviation Administration, and National Aeronautics and Space Administration have informally established a working group on aviation fire systems, which is intended to address flight survivability and safety in view of the impending halon production phase-out. Although this group has met only twice, DOD officials noted that they are hopeful this working group will assist in finding

ways to reduce DOD's reliance on halons as fire-fighting agents on aircraft.

Joint collaboration should enable DOD to more expeditiously identify alternatives and eventually phase out its use of ozone-depleting chemicals. According to DOD, its resources are too limited to fully fund the identification of alternatives for all of its uses of these regulated chemicals. Therefore, by participating with the Environmental Protection Agency, other government activities, and private industry, DOD can leverage other U.S. investments.

## Conserving Regulated Chemicals

DOD is taking steps to conserve ozone-depleting chemicals. CFC and halon recovery and recycling equipment is being evaluated, purchased, and used. As mentioned previously, recovery is done by removing chemicals from existing equipment and storing the chemicals in containers rather than venting or releasing the chemicals when the equipment is serviced, repaired, or retired. The recycling process includes cleaning the chemicals to remove impurities so the chemicals may be reused.

The military departments are beginning to develop equipment specifications and purchase recycling units to conserve the use of these regulated chemicals. For example, the Navy awarded a contract in February 1991 to purchase 75 recovery and recycle units for portable halon 1211 fire extinguishers. According to the Navy, these units will be distributed to aviation-capable naval ships and naval and Marine Corps air stations. The Navy plans to purchase additional units in the future for other Navy and Marine Corps activities.

The Navy has also developed purchasing specifications for CFC-12 refrigerant recovery and recycle units. The units will be used to prevent the release of a CFC refrigerant during operation, maintenance, repair, testing, and disposal of air conditioning and refrigeration equipment. In addition, the Navy has developed and is currently testing a CFC-114 recovery unit.

## Reducing Chemical Emissions

We found cases where DOD has reduced halon emissions into the atmosphere. For example, the Air Force is using a training simulant to maintain fire-fighting proficiency instead of emitting halon 1211. According to the Air Force, fire-fighting students are continuing to receive training on the use of halon and its dispensing systems, but no actual release of halon is taking place. DOD reports that this initiative has reduced the

Air Force's training emissions from portable halon fire extinguishers by 70 percent.

The Navy is using sulfur hexafluoride, an alternative test agent, instead of halon 1301 in certifying room-flooding protection systems. In the past, the Navy verified new systems by discharging halon into the fire test room and measuring the chemical concentration levels throughout the room on every new ship class. According to the Navy, this system testing procedure is the largest source of emissions for halon 1301 throughout industry and the government. In an effort to reduce emissions of ozone-depleting chemicals, Navy researchers identified an alternative test gas that demonstrates the effectiveness of the system without using halon. The alternative test gas is a nontoxic, chemically inert substance with no ozone-depleting potential. The Navy reports that it has eliminated over 60 percent of its atmospheric emissions of halon 1301 by using the alternative test gas.

The Army has also evaluated sulfur hexafluoride and recommended that the vehicle test activities use it instead of halon 1301. According to an Army official, the test gas is being recommended for testing the fire-fighting systems in the Army's combat vehicles.

## Prohibiting Chemicals in Some New Procurements

In some new procurements, the Air Force and Army are prohibiting new systems that use CFCs and halons. More specifically, both military departments have adopted policies that limit ozone-depleting chemicals in new cooling and refrigeration systems, fire-extinguishing systems, and portable extinguishers. For example, in 1988 and 1989, the Air Force required its civil engineering units to (1) limit the use of CFCs in the design, construction, and operations and maintenance of heating, ventilating, and air conditioning systems and (2) eliminate the use of halon fire extinguishers in new facilities housing electronic equipment.

In March 1990, the Army restricted the use of new halon fire-extinguishing systems and extinguishers installed in buildings and structures. The Army allows halon usage only for mission critical electronic equipment facilities with Headquarters, Department of the Army, approval. However, as of September 1, 1991, no electronic equipment facilities have been approved or designated as mission critical. According to Army officials, the use of halons for new fire suppression systems has been essentially eliminated.

# More Needs to Be Done to Ensure a Timely Phase-Out

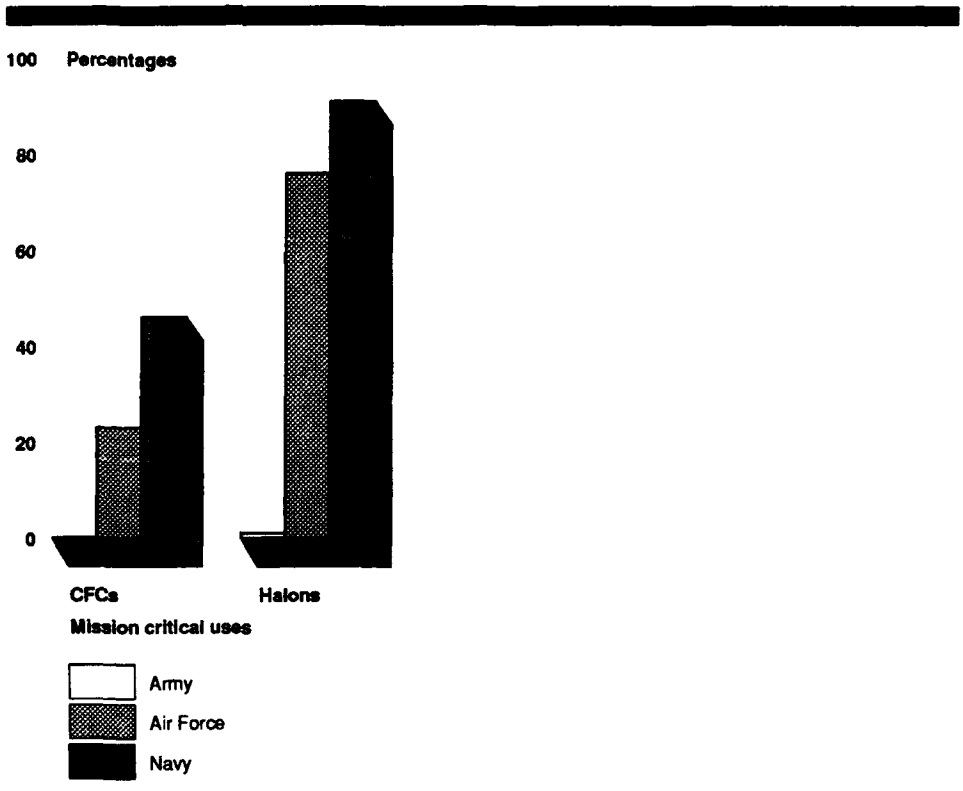
Although DOD has taken steps to reduce the use of ODCs, it has not taken certain actions that are needed to reduce its requirements for strategic reserves and to eliminate its use of ozone-depleting chemicals cost-effectively. Both international treaty and U.S. law require the production and consumption of ozone-depleting chemicals to be phased out by the beginning of the 21st century. Although neither specifically prohibits the use of ozone-depleting chemicals beyond a certain date, given the production phase-out, DOD faces the challenge of eventually eliminating its use of these chemicals.

DOD has undertaken some initiatives that, if effectively implemented, should be a step forward in reducing DOD's dependence on ozone-depleting chemicals. However, DOD still needs to take various actions to reduce its requirement for strategic reserves and to ensure that the use of ODCs is eliminated as quickly as practicable. These include (1) establishing priorities for DOD's use of ozone-depleting chemicals based on mission criticality; (2) identifying where ozone-depleting chemicals are being used; (3) conducting research, development, and testing required to implement alternatives; (4) limiting the use of these chemicals in new and existing systems; and (5) changing military specifications and standards.

## Definition of Mission Criticality Is Vague

As previously discussed, mission critical use of ozone-depleting chemicals in DOD can continue indefinitely if alternatives are not available. Although the Office of the Secretary of Defense has established a definition for mission critical use of ozone-depleting chemicals, this definition is vague and is applied differently by each of the military departments. Figure 3.1 shows the percentage of each military department's 1989 CFC and halon purchases designated as mission critical uses.

**Figure 3.1: DOD's Percentage of CFC and Halon Mission Critical Uses in 1989**




Note: None of the Army's CFC procurement was identified as mission critical and only 1 percent of its halon procurement was designated as mission critical in 1989.

The Army has interpreted the definition of mission criticality very narrowly. Under this interpretation, using halon for explosion suppression in the crew and turret areas of combat vehicles, such as the Abrams tank, Bradley fighting vehicle, and the Sheridan light tank, is the only allowable mission critical use for any ozone-depleting chemical to date. Using this narrow interpretation, the Army identified only 1 percent of its 1989 halon procurement as being required for mission critical uses. The Army's interpretation does not allow any CFC uses to be defined as mission critical. According to one Army official, a broader interpretation would make it difficult for the Army staff to assert the leverage needed to get field activities to implement alternatives and eliminate ozone-depleting chemicals in a timely manner.

The Air Force has identified three mission critical uses for ozone-depleting chemicals: the cooling, cleaning, and fire protection of its weapon systems. CFCs used in specialized electronic cooling components and weapons system pods are considered by the Air Force to be mission

critical. In addition, the large quantities of CFC-113 and methyl chloroform used in manufacturing the inertial guidance system used in the Peacekeeper and Small Intercontinental Ballistic Missile are considered to be mission critical. The only allowable mission critical use of halon is for fire protection for the aircraft airframe and engine systems and for explosion protection in aircraft fuel cells. Under the Air Force interpretations, about 23 percent of its CFC procurements and 76 percent of its halon procurements for 1989 were for usage requirements identified as mission critical.

The Navy considers its use of ozone-depleting chemicals for all shipboard and aircraft refrigeration, cleaning, and fire-fighting as well as its use of halon on flightlines to be mission critical. Under this broad interpretation, the Navy estimates that 46 percent of its 1989 CFC procurements and 91 percent of its halon procurements were for mission critical uses. The Navy's use of CFCs for mission critical requirements include (1) refrigerants in shipboard food-storage refrigeration plants and centrifugal chilled-water plants for cooling various shipboard systems and (2) cleaning agents and degreasing solvents. The Navy's mission critical halon uses include mobile fire extinguishers on flightlines and aircraft carriers, portable extinguishers at shore facilities, and other uses in shipboard machinery rooms, storerooms, and fuel pump rooms.

Using each of the military department's interpretations of mission criticality, about 35 percent of DOD's 1989 ODC purchases were designated for mission critical uses. An Office of the Secretary of Defense official noted that the military departments' interpretations of mission critical uses have not been challenged.

DOD plans to establish strategic reserves to meet mission critical requirements that will remain after the production phase-out. These reserves will enable DOD to continue operating existing systems until (1) alternatives are identified, tested, and implemented or (2) existing equipment is retired from the inventory if modifications are considered to be cost prohibitive. The quantities required in these reserves will be established based on the ODC uses the military departments identify and rank as mission critical. DOD plans to obtain these quantities through recovered and recycled chemicals and bulk purchases. DOD officials could not provide us cost estimates for developing these stockpiles, but noted that ODCs will cost more in subsequent years because of the excise tax imposed by the Omnibus Budget Reconciliation Act of 1989 on each pound of CFC and halon. In addition, costs may increase due to chemical

manufacturers operating at reduced capacities. The costs for eventual disposal are also unknown at this time.

## Total Ozone-Depleting Chemical Usage Has Not Been Identified

DOD has neither identified nor tracked all of its ozone-depleting chemical usage quantities, specific uses, and emissions. DOD Directive 6050.9, "CFCs and Halons," requires the military departments to identify CFC and halon uses and rank them with respect to mission criticality. The military departments have identified their largest chemical uses, which include CFCs for shipboard and weapons system cooling and halons for fire suppression systems in aircraft, ships, and tanks. However, according to DOD officials, specific uses and quantities of smaller ODC usage, such as in cleaning and degreasing equipment, are not known. Without the identification of all specific uses, we believe the military departments will not be able to (1) define and rank total ODC usage, (2) identify and establish funding profiles for projects to develop and test alternative chemicals, or (3) develop a program to quantify and manage ODC strategic reserves.

Generally, the military departments are relying on annual procurement reports to provide information on the quantities used. Although these reports can provide information on whether DOD is making progress in decreasing its yearly purchase quantities, they do not capture data on the specific use of each chemical, where the chemical is being used, and in what quantities.

For example, DOD purchases CFCs that can be used in more than one application. One of the regulated chemicals, CFC-12, can be used as a refrigerant, a sterilizer, or cleaning agent. The annual procurement reports do not specify how or where the chemical is used. The information on ozone-depleting chemical usage quantities, specific uses, and emissions is essential if DOD is to rank its ozone-depleting chemical uses, ensure research is being conducted for its mission critical needs, and determine the quantities it will need to build strategic reserves.

## Research and Development Projects Are Not Given Priority

Research and development programs to identify and implement ozone-depleting chemical alternatives are essential to the accomplishment of DOD's phase-out of these chemicals. In recognition of this factor, Directive 6050.9 requires the military departments to conduct alternative ODC research and development programs as needed to support its mission requirements. DOD estimates the costs to be about $250 million to test, evaluate, and qualify new materials for mission critical applications.

Although the military departments have begun to test and evaluate some ODC alternatives, neither the military departments nor OSD have given adequate funding priority to ensure the development of safe and acceptable alternatives in a timely manner.

Chemical manufacturers are developing alternatives for ozone-depleting chemicals. Their research and funding priorities are based on ODC uses that have the largest known applications. For those uses where DOD is a small user relative to the civilian industry, it can benefit from the private sector's innovations and efforts to develop alternatives. However, some DOD applications are unique to the military mission and have no civilian equivalent use. These uses include (1) CFCs for shipboard and electronic weapons systems cooling equipment and critical electronic and optical surface cleaning applications and (2) halons for fire suppression in aircraft engine systems and airframes, tactical ground vehicles, and ships.

One example indicating that ODC research and development has not been given adequate priority is the Navy's inability to implement its plans for testing and evaluating alternatives for ozone-depleting chemicals. In fiscal year 1991, the Navy planned to conduct 11 CFC and halon research and development projects. The majority of the projects were to focus on identifying refrigerant alternatives for the Navy's unique ship and submarine usage. The $8.1 million the Navy stated it required for these projects was not included in the approved 1991 President's budget. According to Navy officials, the Navy reprogrammed approximately $1.5 million from other areas to fund some of the planned research.

Another example is the Army's decision not to provide funding to conduct research and development projects on ozone-depleting chemical alternatives during fiscal year 1992. As part of the Army's Manufacturing Technology Program, research and development projects are to be conducted on environmentally acceptable materials, treatments, and processes, including research for ODC alternatives. In fiscal year 1991, the Army conducted three research projects evaluating CFC alternatives to replace its use of solvents in cleaning metal parts. However, according to Army officials, in fiscal year 1992, funds were reduced within the Army budget for conducting research on environmentally acceptable materials, treatments, and processes as part of its Manufacturing Technology Program. As a result, no Army Manufacturing Technology funds will be provided to evaluate CFC alternatives.

A third example of DOD's lack of attention is its handling of the Strategic Environmental Research and Development Program. The National Defense Authorization Act for Fiscal Year 1991 (P.L. 101-510) required DOD to establish a centralized research program to provide support for basic and applied research and development of technologies that can enhance the capabilities of the military departments to meet their environmental obligations. Congress appropriated $150 million during fiscal years 1991 and 1992 for environmental research, development, testing, and evaluation projects.

ODC research and development projects qualify for funding under this program, and the military departments have submitted for funding consideration at least 12 proposed ODC research and development projects. However, as of September 9, 1991, 10 months after the law was enacted, no projects have been approved. According to OSD officials, no funds will be released until a 5-year research and development plan is prepared and approved on the research and development technologies that can enhance the capabilities of the military departments to meet their environmental obligations.

The CFC Advisory Committee Report issued in July 1991 recognized that DOD must give priority to environmental research and development for ODC mission critical applications. The report noted that the technical complexity of the ODC elimination effort requires the development of new incentives and the maximum use of existing incentive mechanisms to encourage research and development to support the elimination program. According to the report, committing and coordinating resources will be critical in meeting the elimination schedules cost-effectively.

## Equipment Using Regulated Chemicals Continues to Be Installed on Existing and New Systems

DOD is continuing to install equipment that uses ozone-depleting chemicals into existing and new aircraft and ships. Although DOD's directive on managing CFCs and halons requires the military departments to establish review procedures to prevent or minimize CFC and halon use in existing and future systems, none of the military departments have established such procedures.

Both the Air Force and Navy are installing equipment that uses CFCs and halons in existing systems without assessing whether this is the only option in light of the phase-out of these chemicals. Most of these modifications were approved before either ratification of the 1987 Montreal Protocol or the agreement to phase out the production of ODCs. According to the Navy's Aircraft Carrier Air Conditioning/Chilled Water

Improvement Plan and an Air Force official, the installation of equipment that uses CFCs and halons will provide increased reliability and improved fire-fighting capabilities, thereby reducing risks to potential future loss of lives and systems.

For example, the Air Force is installing two halon fire suppression systems into the engine compartment and the auxiliary power unit of each KC-135 aircraft. The KC-135 fleet, which was produced about 30 years ago, has been undergoing extensive modifications since 1982—7 years before the Montreal Protocol went into effect. Another example is the additional halon fire suppression system being installed on the B-1B aircraft. The Air Force prepared a risk assessment that addressed the probability of losing a B-1B due to fire. However, according to the Air Force, because there was no requirement to do so, the assessment did not consider justifying the use of an additional halon system or comparing the halon systems with other alternatives.

The Navy is installing equipment that uses ODCs in many of its existing ships and aircraft. For example, portable fire extinguishers containing carbon dioxide—a non-ozone-depleting chemical—are being replaced with halon fire extinguishers in the electronic spaces on 226 surface combatants. The Navy is also removing older air conditioning systems and replacing them with newer, more modern shipboard air conditioning systems. Both the old and new systems use ozone-depleting chemicals. As of June 1990, the Navy had scheduled to remove 26 of the 102 older cooling systems in its inventory during fiscal years 1991 through 1996. The Navy is also installing halon fire-fighting systems in its A-6E aircraft.

Equipment using regulated chemicals is also being installed into new systems. For example, the Air Force is currently planning to install halon fire suppression systems in the new C-17 aircraft. One system will be installed in the engine compartment and another in the auxiliary power unit. The Air Force is also installing a halon fire suppression system in the engine compartment of each B-2 aircraft in production.

Although some of these installations on existing or new systems may be required, others may not be justified based on the planned phase-out of ODCs. The establishment of criteria for reviewing proposed installations of this kind would help to ensure such installations are not made unless they are adequately justified.

## Military Specifications and Standards Continue to Require the Use of Regulated Chemicals

DOD has revised only 1 of the approximately 9,600 military specifications and standards that call for the use of ozone-depleting chemicals. DOD's directive on managing CFCs and halons requires the military departments to review and modify military specifications to permit the use of new processes, techniques, or chemicals for requirements currently being met by CFCs and halons. DOD estimates that approximately 900 military and federal specifications directly specify the use of CFCs, halons, and chlorinated solvents, while about 8,700 documents indirectly specify the use of these ozone-depleting chemicals. DOD estimates that it can take anywhere from 3 months to 3 years to revise a specification or standard, depending upon the extensiveness of the change. In addition, estimates on the total administrative cost for changing these military specifications and standards are to be about $35 million.

Military specifications and standards function as technical requirements in contracts. These documents specify the particular materials and processes contractors must use in the manufacture or modification of military systems. Specifications describe products that DOD procures regularly, while standards control practices, processes, and technologies. Noncompliance with an applicable specification or standard could potentially result in DOD's rejection of the item as defective. Additionally, a great deal of commercial manufacturing is done using military specifications, particularly where product reliability is a factor.

In 1991, DOD completed its first revision of a standard, promulgating a change from requiring ODCs to promoting the use of safe and acceptable alternatives. This revision was accomplished after 3 years of comparing and testing CFC-113 alternatives to assess their cleanliness and effectiveness in cleaning electronic circuit boards. In February 1991, DOD published Military Standard 2000A, "Standard Requirements for Soldered Electrical and Electronic Assemblies." This performance-based standard describes the required performance to clean circuit boards. The revised standard not only dropped the requirement for using CFC-113 but also encouraged manufacturers to use safe and acceptable alternatives. (A chronology of key events leading to the publication of this standard is presented in appendix I.)

We queried each of the military departments about its planned strategy for revising military specifications and standards that currently require the use of ozone-depleting chemicals. Air Force and Navy officials told us that they generally intend to wait for alternatives to be developed, qualified, and produced before changes are made to military and federal specifications and standards. Using this approach, as alternatives are

identified and approved, military and federal specifications and standards can be revised to use safe and acceptable substitutes. However, the actual change to the specification cannot occur until the suggested alternatives have been tested and determined to meet the original operational requirements. The process of revising each specification is time-consuming, especially if more environmentally acceptable chemicals are being continually proposed as alternatives.

Other approaches may be worth considering to expedite the use of safe and acceptable alternatives. An Army official said the Army intends to adopt nongovernment standards, where appropriate, instead of waiting for alternatives to be identified and approved. He noted that most of the ODCs the Army uses are also used in similar commercial sector applications. Nongovernment standards include specifications and other forms of product, process, or practice descriptions promulgated by the private sector. According to the Army official, commercial specifications are usually more responsive and compatible to existing environmental restrictions and regulations.

Another approach is the use of performance-based standards. Determining the required performance needed to change a military specification or standard may take considerable time to accomplish, as occurred in the development of the performance-based standard for cleaning printed circuit boards. However, using performance-based standards would move away from the current practice of requiring the use of environmentally unacceptable chemicals.

The July 1991 CFC Advisory Committee Report noted that changes are needed in the military specifications and standards process. The report concluded that DOD should eliminate unnecessary specifications of ODCs in military specifications by (1) ranking the military specifications for revisions, (2) adopting nongovernment industry standards, and (3) developing military specification revision teams focused on ODCs. These steps would enable DOD to expedite the elimination of ozone-depleting chemical use and facilitate the use of alternatives.

## Conclusions and Recommendations

International treaty and U.S. law restrict the production and consumption of ozone-depleting chemicals but not their use. Even though the use of ozone-depleting chemicals is not restricted, the ultimate intent is to eliminate their use. With this in mind, it is essential that major ODC users take a proactive rather than a reactive position in working toward the overall phase-out of ozone-depleting chemicals.

DOD is a large user of ozone-depleting chemicals. Additionally, because many ODC products it uses have applications that are considered to be critical to the national defense mission, DOD does not plan to phase out the use of these products until safe and effective alternatives are developed, tested, and qualified. DOD has undertaken some initiatives which, if effectively implemented, should move DOD a step forward in reducing the military's dependence on ozone-depleting chemicals.

However, DOD's plan for managing the ODC phase-out will allow the continued use of ozone-depleting chemicals for several decades beyond the production phase-out of these chemicals. DOD plans to recover, recycle, and reclaim existing chemicals, as well as to purchase added quantities of these chemicals to create the strategic reserves it will need to meet long-term requirements. Although the development of these strategic reserves may be necessary to allow the continuation of critical military functions, this practice may also be a disincentive for promoting the implementation of safe and acceptable alternatives.

We believe that DOD can initiate positive actions now that will expedite the process of phasing out the use of ozone-depleting chemicals. These actions are essential if DOD is going to be successful in minimizing the reserves of ozone-depleting chemicals and avoiding the continued use of these regulated chemicals further into the 21st century than necessary. Additionally, minimizing the size of the strategic reserves will decrease the amount of procurement and eventual disposal costs for ozone-depleting chemicals.

To accomplish these objectives, we recommend that the Secretary of Defense

- clarify the definition of mission critical uses to minimize continued use of regulated chemicals and ensure consistent approaches among the military departments;
- establish a mechanism to track its specific uses, quantities, and emissions to ensure all usage will be identified and eliminated;
- ensure the appropriate priority is given to research and development for applications that have no ongoing commercial research;
- establish criteria for reviewing ongoing and proposed projects that use regulated chemicals in existing and new systems to ensure these uses are justified; and
- expedite the use of nonmilitary specifications and standards to replace the military specifications and standards that currently require the use of ozone-depleting chemicals.

# Key Events in Revising Military Standard 2000

| | |
|---|---|
| September 1987 | The United States, along with 23 other nations and the European Economic Community, signed the Montreal Protocol on Substances that Deplete the Ozone Layer. The treaty reduced the production of CFCs by 50 percent of the 1986 production levels in mid-1998 and froze halon production to 1986 levels in 1992. |
| March 1988 | Established an Ad Hoc Solvents Working Group consisting of DOD, the Environmental Protection Agency, and industry representatives to discuss alternative cleaning agents for CFC solvents and develop procedures to evaluate alternative cleaning materials to reduce CFC usage in electronic assembly cleaning. |
| January 1989 | The Montreal Protocol went into force.<br><br>Issued Military Standard 2000, "Standard Requirements for Soldered Electrical and Electronic Assemblies," that contained the requirement to use CFCs.<br><br>Completed the benchmark testing methodology for testing solvent alternatives. |
| February 1989 | Completed tests to establish CFC-113 cleaning performance. |
| March 1989 | Began to make technical changes to military standard 2000. |
| June 1989 | Published final results to promulgate CFC-113 cleaning performance. |
| September 1989 - Continuing | Tested alternative cleaning solvents—eight solvents have been found to clean as well as or better than CFC-113. An additional five solvents are planned to be tested in the near future. |
| March 1990 | Drafted changes to military standard 2000. |
| May 1990 | Began to coordinate the proposed military standard changes through DOD and industry. |
| June 1990 | The Montreal Protocol was amended to eliminate the production and consumption of CFCs and halons by the year 2000. Amendments were also adopted to phase out the production and consumption of methyl chloroform by 2005 and carbon tetrachloride by 2000. |
| July 1990 | Completed coordination of the proposed military standard changes through DOD and industry. |
| August 1990 | Prepared the final military standard for publication. However, the Navy prepared a new revision of the standard because the document contained an excessive number of detailed requirements and coordinated the document through the senior service executives. |
| November 1990 | The President signed the 1990 Amendments to the Clean Air Act into law, implementing the June 1990 changes to the Montreal Protocol and mandating more stringent reductions of CFCs and halons. |
| February 1991 | Published Military Standard 2000A, "Standard Requirements for Soldered Electrical and Electronic Assemblies," encouraging manufacturers to discontinue the use of CFCs and allowing the use of alternatives. |

# Major Contributors to This Report

## National Security and International Affairs Division, Washington, D.C.

Norman Rabkin, Associate Director
Julia Denman, Assistant Director
Penny Stephenson, Evaluator-in-Charge